# Environmental Monitoring of Shelf Life Material Using Automatic Identification Technology (AIT)

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Shelf Life

# Briefing Outline

- AIT Description
- DoD AIT Program Status
- What can AIT enable?
- What are the potential benefits?
- AIT for Shelf Life Management
- Advanced Technology Ordnance Surveillance (ATOS)
- Knowledge Management Recommendation
- Implications for DoD Shelf Life Management

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# AIT Definition

- AIT is not a system or a single product, but a family of commercial technologies that provide a spectrum of enabling capabilities for DoD to provide source data automation to information systems and transform supply chain management processes and other functional areas

- AIT devices can automatically identify, locate/track, and monitor supplies and equipment

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# Automatic Identification Technology

" AIT is a suite of technologies that enable the automatic capture of source data, thereby enhancing the ability to identify, track, document and control deploying and redeploying forces, equipment, personnel and sustainment cargo. "
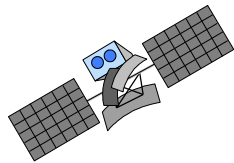
*Logistics AIT CONOPS – November 1997*

AIT devices can automatically identify, locate/track, and monitor supplies and equipment

# What Are The AIT Technologies?



SENSORS

GPS

RFID

RFDC

OCR & Machine Vision

Speech Recognition

D

EDI

STS

AIT

Bar Code

Bar Code

Contact Memory

OMC

Biometrics

MEMS

Satellite Monitoring Communications

Card Tech.

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# AIT Identification Location and Tracking

**Identification Options for System-wide Visibility**

Multi-level Identification

**CONVEYANCE**
- Bar Code 2D Label
- Optical Cards or Ta...
- RFID Tags
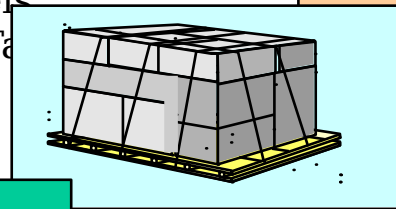- GPS Capability
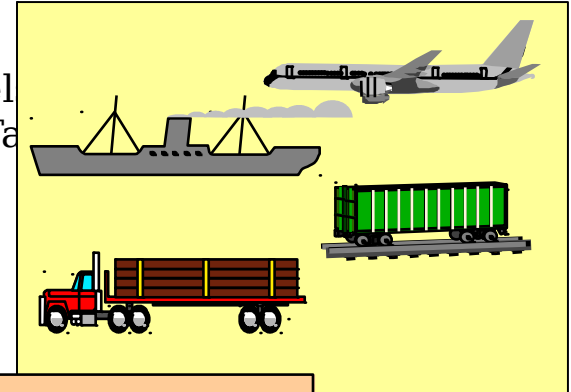
**CONTAINER**
- Bar Code 2D Labels
- Optical Cards or T...
- RFID Tags
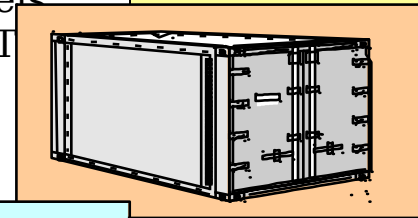
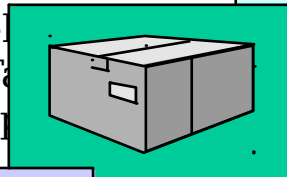**PALLET**
- Bar Code 2D Labels
- Optical Cards or Ta...
- RFID Tags

**MULTIPACK**
- Bar Code 2D Label...
- Optical Cards or Ta...
- Embedded RF Chip...

**PART**
- Bar Code 2D Labels
- Inscribed Part Numbe...
- Embedded Microchip...

Redundancy in Identifying Assets

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# Characteristics of RFID

## *Characteristics*

- A form of electronic labeling that can be updated (read/write)
- Can be interrogated at a distance and hands free in a fast and reliable manner- Permits "On-the-Fly" reads
- Depending on the frequency, does not require physical sight or contact between reader/scanner and the tagged item.
- Can contain large quantities of unique digital info
- Greater placement flexibility on or in an item
- Virtually low maintenance on the product
- Extremely low error rate
- Can be interfaced with micro sensors to collect previously non-existent environmental data

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# AIT Objectives

Infuse AIT into the DoD Logistics AIT Business Processes

**Facilitate Source Data Collection**

**Reduce Logistics Processing Times**

**Improve Data Accuracy**

**Enhance Asset Visibility**

Improve Support to the Warfighter

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# Players & Roles

**Principals**

DUSD (L&MR)
JS-J4
Director, DLA
DCINC, TRANSCOM
Army
Navy
Air Force
Marines
DUSD (AS&C)
DISA
DARPA

- Logistics IPT
- DoD Logistics AIT Standards Group
- CAC IPT
- AIT Framework Team

**Mission**

**Scope**

- DUSD(L&MR) & JS-J4 designated DLA as Executive Agent (EA) to:

  *Promote, manage, coordinate, and document the application of DoD and Joint Logistics AIT doctrine, technologies, and processes in support of the Warfighter*

- Operate as a joint organization

- ...vely supported by

- ...vided to EA by DUSD(L&MR), JS-J4 and AIT Principals

# DoD AIT Milestones

# CENTCOM
# Operation Enduring Freedom

## AIT Lessons Learned

- Institutionalize how we go to war
  - **Train as we fight--smooth transition to war**
  - **Difficult to merge into coalition operations**

- Detailed ITV picture
  - **Takes multiple systems to obtain complete ITV picture**
  - **Queries are difficult to build for complete ITV picture**
  - **Understanding of ITV is inconsistent throughout DoD**

- Fund AIT technology
  - **Accelerate AIT/AIS fielding**
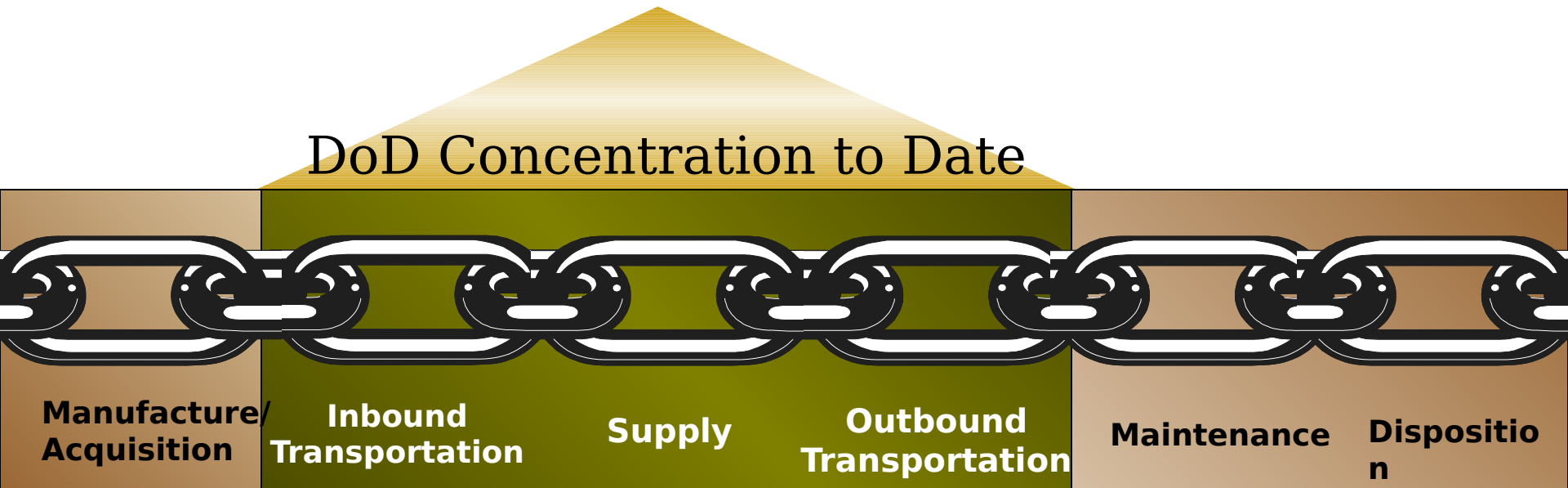  - **Provide AIT/AIS contingency funding**

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# AIT Program:  Next Steps

- Revise DoD Logistics Implementation Plan for AIT to encompass entire supply chain

- Achieve Supply Chain interoperability by engaging International/American standards groups

- Proliferate AIT requirements in DoD policy

- Implement DoD AIT policy…Enforce the policy

- Continue to work special AIT actions

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# DoD Logistics AIT Implementation Plan Revision

DoD Concentration to Date

| Manufacture/ Acquisition | Inbound Transportation | Supply | Outbound Transportation | Maintenance | Disposition |

Maintenance activities represent 50% of DoD Log costs and 68% of Log workforce.

AIT supports end-to-end distribution

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# Supply Chain Interoperability

| Supply Chain | Reqs. | Data Stds | Policy & Procd. |
|---|---|---|---|
| Sustainment Planning | Part Mark | I, II, III, A, *, # | DoD 5000, MILSTD 130 |
| Manufacturing Procurement | Packing Slip | I, II, III, IV, B | DoD 5000, 4140.1R DTR |
| Supply | Package Mark | I, II, III, V, C, D, # | DoD 4140.1R, MILSTD 129 |
| Transportation | Shipping Label | I, II, III, IV, B, E, F | DoD 4140.1R, DTR |
| Maintenance | Repair Order | I, II, III, IV, B | DoD 4151.18 MILSTD 130 |
| Reutilization | Packing Slip | I, II, III, IV, B, E | DoD 4140.1R, MILSTRP DoD 4160.21-M |

**Legend**

**International**
I     ISO 15416 –Print Quality and Conformance
II    ISO 15418 – Data Application Identifier Standard
III   ISO 15434 – Syntax for High Capacity Media
IV    ISO 15394 – Packing: Bar Code and 2D Symbols for Transport Shipping & Receiving Labels
V     ISO 15420 – Bar Code Symbology Specification – EAN/UPC

**ANSI**
A     EIA 706: Electronics Industries Association Component Marking Standard

**ANSI (cont'd)**
B     MH10.8.1M
C     EIA 624: Electronics Industries Association Product Package Bar Code Label Standard
D     UCC1: General Specification
E     UCC6: Application Standard for Shipping Container Codes
F     EIA 556-B

**Industry**
*     EIA 802: Electronic Industry Alliance Product Marking Std
#     AIAG B4: Parts Identification and Tracking

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# Implement DoD AIT Policy

- Reengineer logistics business processes for current AIS in order to fully integrate AIT

- Fully integrate AIT into new logistics AIS

- Emphasize AIT tactics, techniques, procedures in schoolhouses

Requires AIS owners' attention

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# Maintenance Data Element Standardization

- Aviation maintenance/configuration management standard data elements

- Ammunition marking with 2D
  (item, pallet, container)

- Future standard data element focus
  – Watercraft (Navy & Army)
  – Tank Automotive
  – Other commodities



Supports condition based maintenance and total lifecycle management

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# MIT Auto ID Center

**End User Sponsors**

**Technology Sponsors**

ELECTRONIC PRODUCT CODE

- **EPC code can be used from food to drugs to assemblies and components.**

- **Naming scheme also accommodates depth throughout the Supply Chain, including vehicles, pallets, containers, packages and items.**

## 01.0000A89.00016F.000169 DC0

Header
0-7 bits

EPC Manager
8-35 bits
256M manufacturers

Object Class
36-59 bits
SKU or NSN

Serial Number
60-95 bits
**Unique Object ID numb**

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# What can AIT enable?

- How much time and effort is expended in:
  - Manually entering data into computerized or manual information systems, and other record keeping?
  - Counting material that you have?
  - Looking for material that is not where it should be?
  - Reconciling inventory records with inventory counts?
  - <span style="color:red">Inspecting and testing material to be sure of its condition?</span>
  - Checking and rechecking documents, forms, labels, and equipment nameplates to ensure receipts and issues are correct?
  - Requisitioning and handling unnecessary material (Needed material that was on site but not recorded, or on its way in the pipeline but not visible)?
  - <span style="color:red">Demilitarization and Disposal</span>
- AIT can radically reduce the requisite time and effort to accomplish these tasks and more

Shelf Life

# AIT Potential Self Life Benefits

- Support Material Management requirements for shelf-life and equipment prognostics/diagnostics through automated, remote monitoring

- Create a safer and more secure environment

- Save considerable work and costs by:
  - Streamlining
  - Consolidating and
  - Eliminating non-value-added processes

- Has applications beyond supply chain functions:
  - Access control, security monitoring, foreign substance detection, substance deteriorization deteriorate

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# Current DoD Shelf Life Program

- Inventory approximately $3.1 B

- Includes approx 60,000 chemical protective clothing and equipment, food, packaged POL, batteries, tires, paints, hoses, o-rings, sealants, adhesives, pharmaceuticals

- Type I and II Categories IAW DoD

Since other supply classes have shelf life issues, how can we maximized knowledge sharing?

Shelf Life

# Implementation Challenges

- How long and how much effort does it really take now? (Cost Metrics?)
- Standards: Pick anyone you wish
- Technology: "Lets wait for the next big thing"
- Functional Roles: How do you "save" a half of a work year, or half of a sailor?
- Functional Relationships: Don't need as many support people, if you have less people and equipment to support
- Organizational Friction: Creating consensus
- Divergence vs. Convergence in IT Systems

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# AIT Decision Point



Decision to Deploy
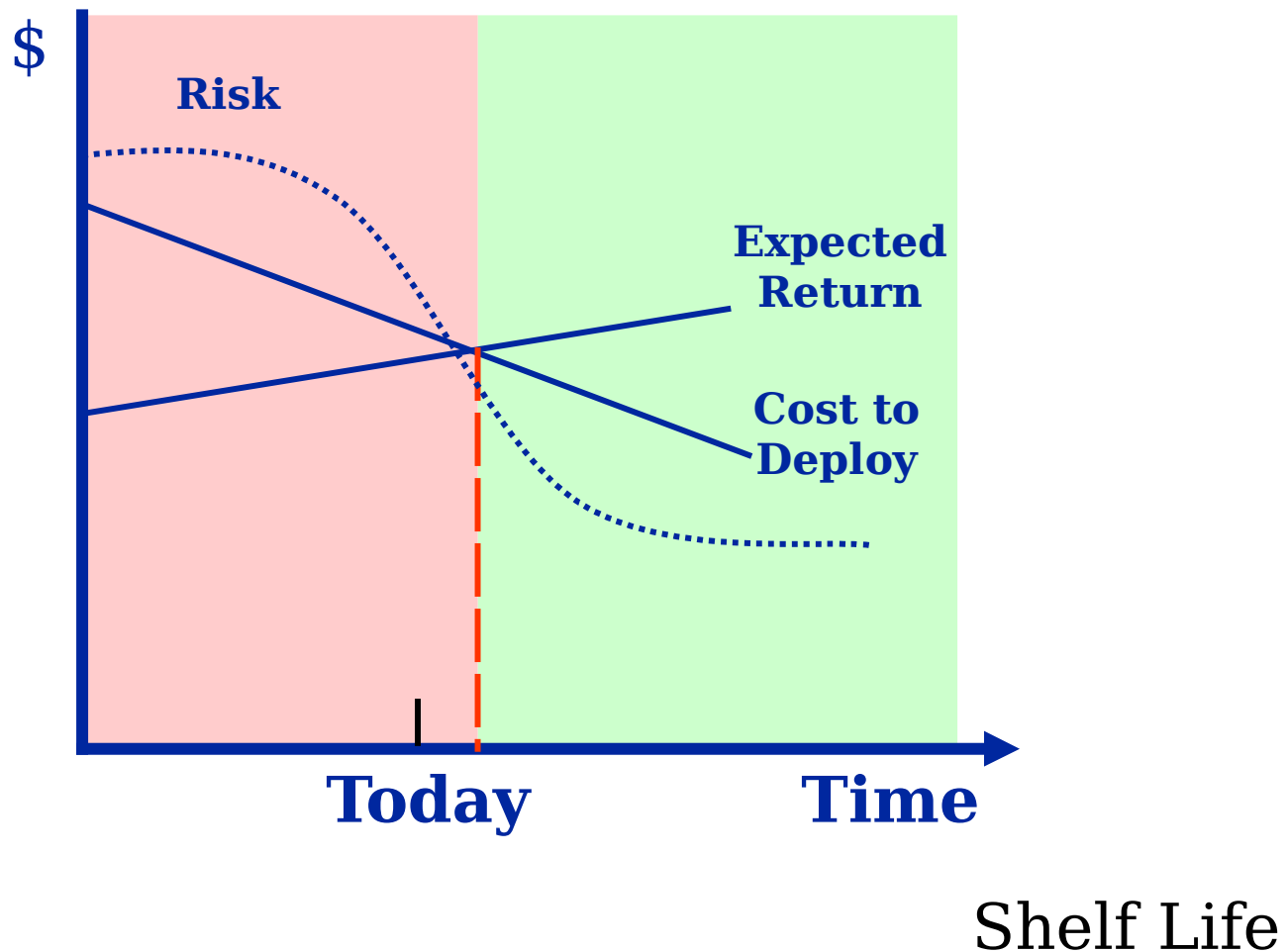
# ATOS ACTD Overview

- An ACTD takes <u>mature</u> technology and puts it in the hands of the warfighter to assess Military Utility

Technical Manager / Transition Manager

Operational Manager
USAREUR
USAFE
CINCUSNAVEUR

Demonstration Manager / Demonstration Site

Independent Test Agency

- ATOS Demonstrations for Military Utility Assessment to be conducted at Crane Army Ammunition Center, Miseau Army Depot, and on two CINCLANTFLT Ships, June-August 2003

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# Field a system and develop associated standards to…

"Give ordnance managers the ability to accurately locate and continuously determine the status of individual munitions on a near real-time basis while simultaneously updating predictions of their future condition and performance with a high level of confidence."
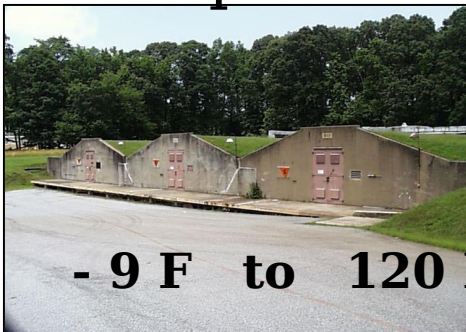
Shelf Life

# Safety & Reliability Background

- **Limitations in Ordnance Surveillance**

  – Sampling based on age vice age & weapon life-cycle environmental exposure

  – requires destructive testing



- 60 F  to  <180 F

- 20 F  to  130 F

- 9 F  to  120 F

Magazine Storage   Transportation        Field Storage

Shelf Life

**erage 1 error in approximately 80-100 key stro**

```
1234F4FS4D4F44G4SD4SDFG4S4DG4G4GG77G44G774
65DD4DHJJ5D5S5E5THG1H4G56R6D2DFG4G5G5F6D6
5G5G5G5T8T8YY5F5FF21FFFF5F52225555G22G5G5F4F
G2G55FF2R2R5F85FF22F5G5T5TTTT52T3467589545134
55453545624524584568451145D5G5JH5J5DFGDFG5DFGS
52456555245526623823848235262225456824852/2456522
56345463456453441342561613452643783RTYTERTYY
FYYYY3567LDFDF4467456735923-02L234523423453332
```

- **70%** of data hand keyed into computers
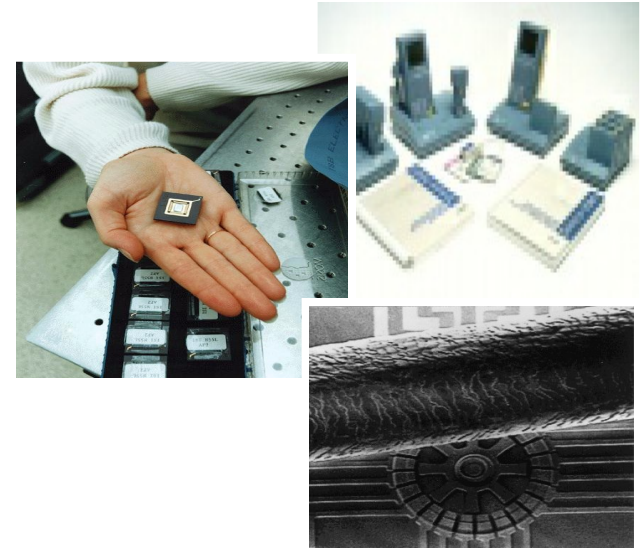came from     anoth       uter
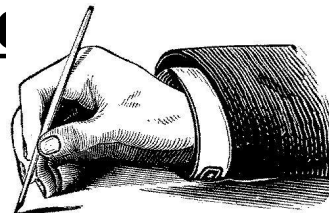
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# ATOS Proposal

## Combine two technologies on a small electroni

✓ **Radio Frequency Identification (RFID)**
  - Low Power, Active ASIC Radio Transmitter ( <40 µW)
  - Range (~ 300 ft.)
  - Low Cost
  - High Detection (> 99%)
  - High Battery Life (> 5 years)
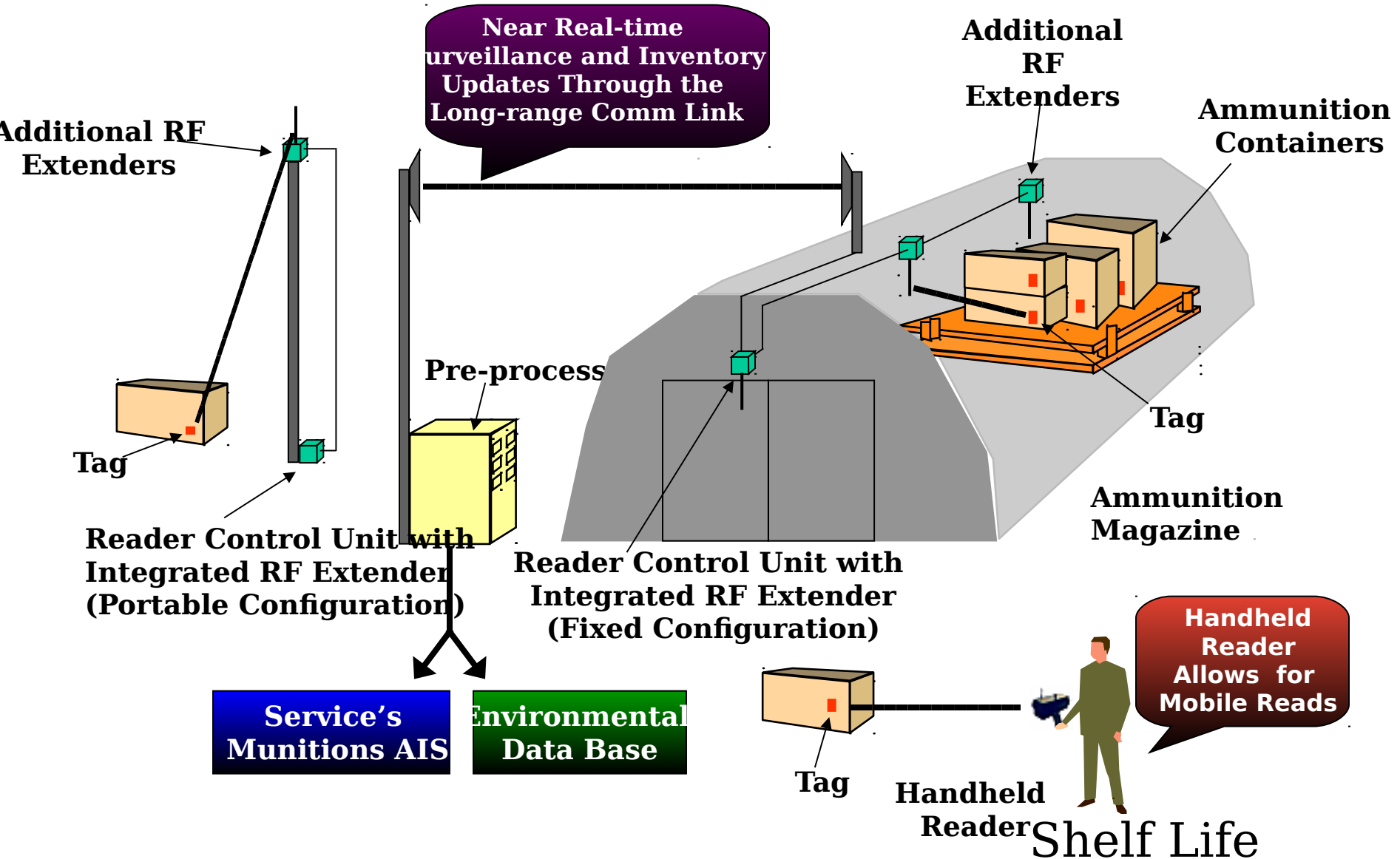  - Non-Volatile Read/Write Memory

✓ **Sensors**
  - Temperature, Humidity, Shock,
  -  Vibration, Acoustic, Chemical
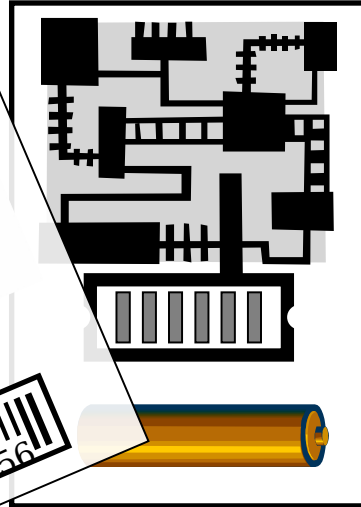  - Sensor array tailored for each weapon system if required

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# *ATOS Concept*

**Near Real-time Surveillance and Inventory Updates Through the Long-range Comm Link**

**Additional RF Extenders**

**Ammunition Containers**

**Additional RF Extenders**

**Tag**

**Pre-process**

**Tag**

**Ammunition Magazine**

**Reader Control Unit with Integrated RF Extender (Portable Configuration)**

**Reader Control Unit with Integrated RF Extender (Fixed Configuration)**

**Service's Munitions AIS**

**Environmental Data Base**

**Handheld Reader Allows for Mobile Reads**

**Tag**

**Handheld Reader**

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# Tag Data Elements



ID: 123456

**ATOS**
ADVANCED TECHNOLOGY ORDNANCE SURVEILLANCE

123456

## Tag Data

•Tag Serial No.

•Battery Mfg. Date

•Package ID

## Sensor Data

• Temperature Historical Data

• Humidity Historical Data

## Threshold Flags

• Temperature Min. and Max. Flags

• Humidity Min. and Max Flags

• G-Level Shock Flag

## Asset Data Elements

•**DOD Identification Code (DODIC)**
•**National Stock Number (NSN)**
•**Quantity per Tag**
•**Item Serial Number(s)**
•**Lot Number(s)**
•**Condition Code (CC)**
•**DOD Activity Address Code (DODAAC)**
•**Unit Identification Code (UIC)**
•**Storage Routing Identifier Code (RIC)**
•**Document Number**
•**Consignee & Consignor**
•**Ownership Code**
•**Purpose Code / Activity Class Code**
•**Storage Point Code**
•**Cognizance Code**
•**Account Code**
•**Acceptance Code**
•**Date of Last Test (DOLT)**
•**Maintenance Due Date (MDD)**
•**Type Next/Last Inspection & Due Date**
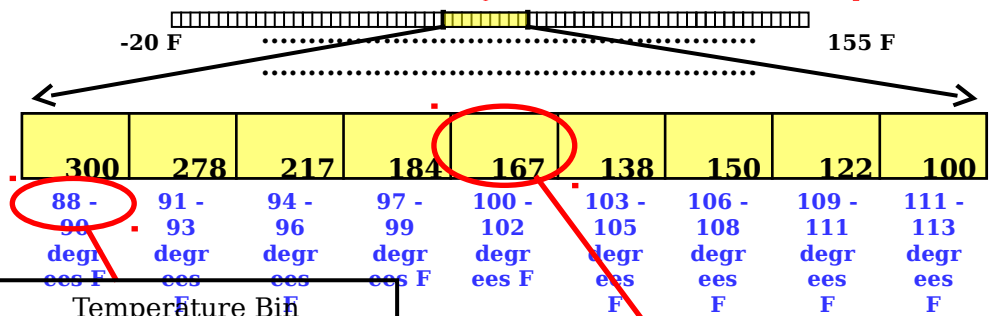•**Defect Code**

# Surveillance Data
## (Multiple Lots)
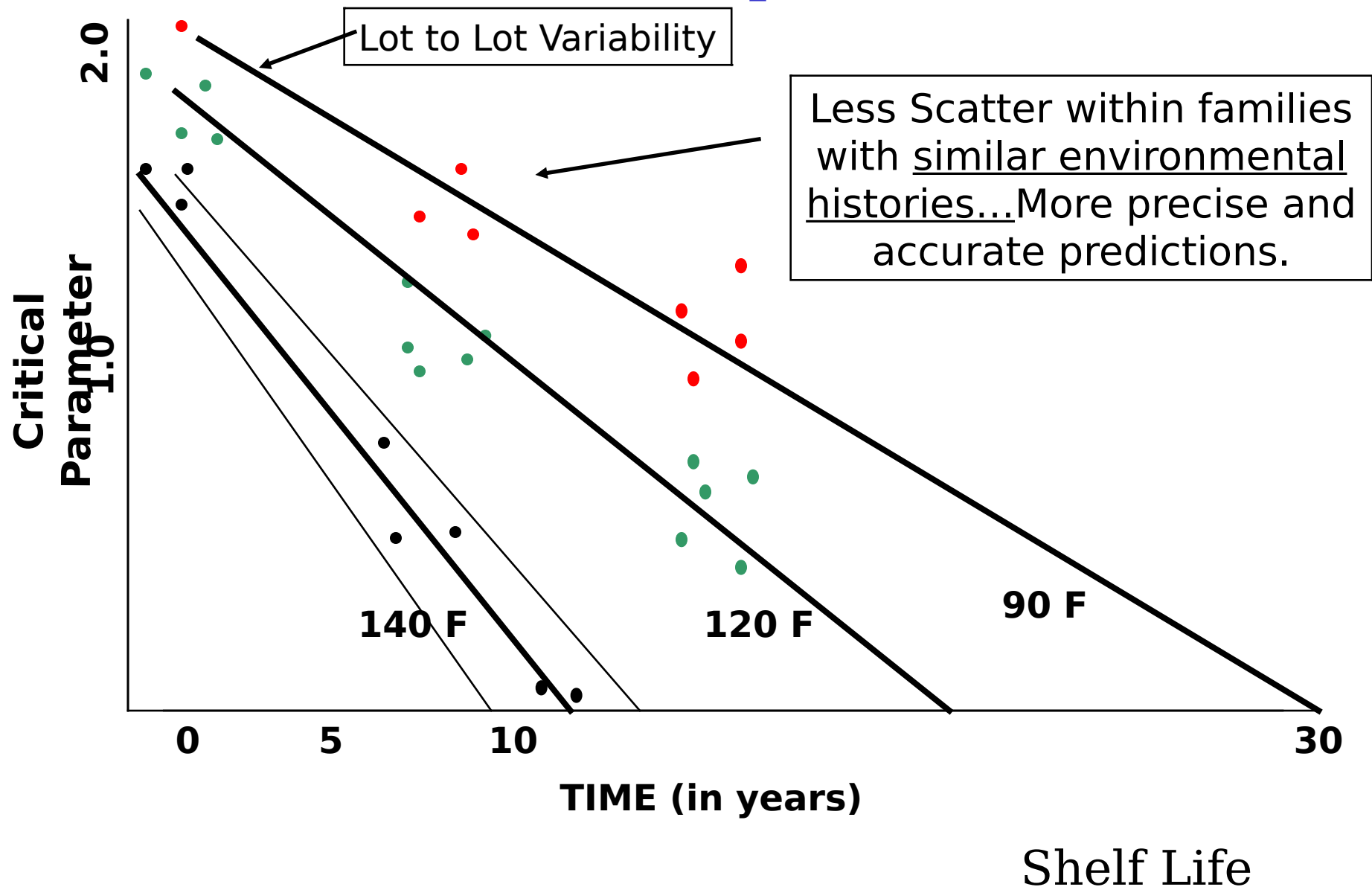
# Operational Environment



Temperature Profile (-20 F to 155 F)
Over 1500 years of data (1 hr sampling rate)
180 bytes Memory Required (60 - 3°F Bins)

-20 F                                                                    155 F

| 300 | 278 | 217 | 184 | 167 | 138 | 150 | 122 | 100 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 88 - 90 degrees F | 91 - 93 degrees F | 94 - 96 degrees F | 97 - 99 degrees F | 100 - 102 degrees F | 103 - 105 degrees F | 106 - 108 degrees F | 109 - 111 degrees F | 111 - 113 degrees F |

Temperature Bin
3 bytes Memory per Bin
Size optimized for sensor accuracy
Recommended Size = 3 ° F

Number of Data Points within Bin
Starts at 0, increments by 1 per exposure
16,777,216 maximum counts per bin
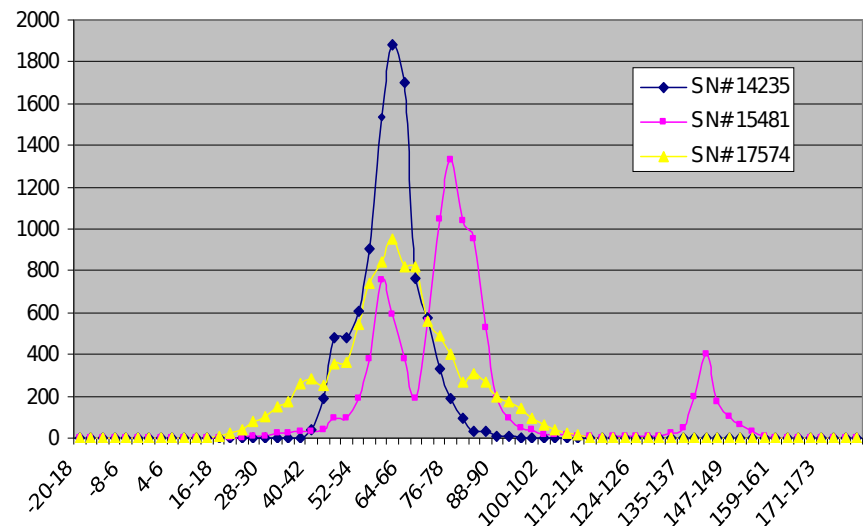
# ATOS Products/Deliverables

- **Fully tested, MEMS-capable RFID system with temperature and humidity sensing**
  - Explosives Safety and Security policy compliant
  - Adapted to authorized international frequencies
  - Installed & fully operational on two ships and in two land-based magazines

- **Generated data that uses emerging DoD standard data identifiers**

- **Software interfaces**
  - Compatible with Service Automated Information Systems (AIS) and Quality Evaluation/ Assurance (QE/QA) databases
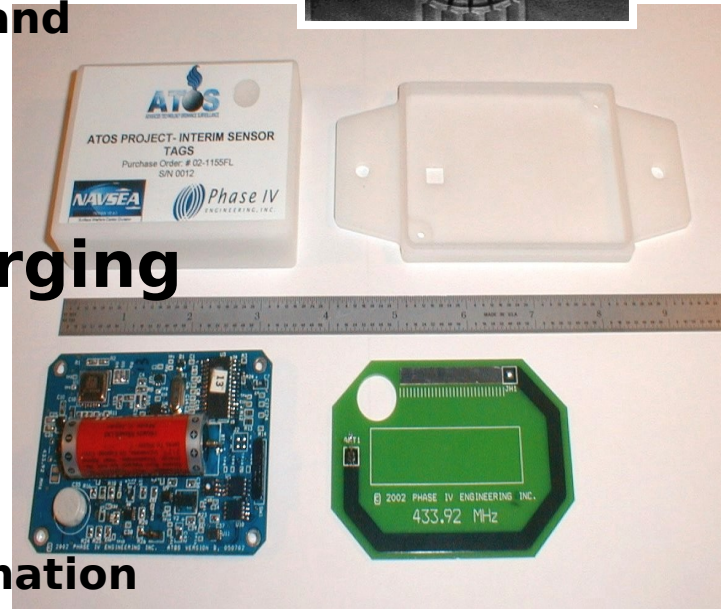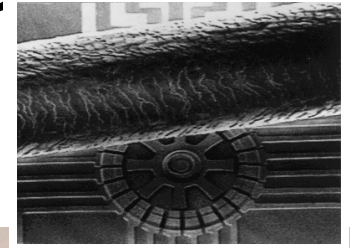
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# ATOS Benefits

- Fully automated item MILSTRAP (receipt/issue/transfer) transactions
- Standard MILSTRIP & MILSTRAP transaction feeds for any DoD inventory AIS
- Periodic and on-demand inventory status (by location and condition)
- Serialization of pallets/containers
- Life-cycle environmental history at the pallet/container level

Shelf Life

# ATOS Benefits

- Provide source data for existing Predictive and Statistical Models (ie. Cumulative Damage Model)

- Allow for "Smarter" Surveillance, by identifying test samples Based on exposure to adverse conditions and/or Known Aging Trends

- "Flag" the Occurrence of Environmental conditions or events, like over-temps and drops, that may result in damage or failure

- Reduce the overall time and costs associated with Engineering Investigations, by providing insight into the mode and mechanism of the failure.

- Provide insight as to whether the problem is an isolated occurrence or applicable to the entire population.

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# ATOS Summary

- ATOS provides both improved asset visibility and improved stockpile safety, security and reliability
- ATOS automates the receipt and inventory process
- The ROI calculated for the Navy shows:
  - Saves 373 Sailor work-years annually
  - Cost savings/avoidance of $41.4M annually
- ATOS is easily modifiable for other commodities
- Successful transition requires all services to participate in planning and budgeting
- More can be achieved by collaborating on improving sensors, developing algorithms and models
- Goal is to continue to improve system and

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# Implications for Shelf Life Management

- Environmental experience is a more important factor for determining material shelf life than age alone.
- AIT is evolving rapidly and new devices have demonstrated the capability to reliably and cost effectively monitor key environmental factors with a high level of precision
- Now never-before-available data can be generated and then correlated with stock surveillance test results, which can then be used to greatly improved aging models and subsequently enable more precise shelf life predictions

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# http://www.ih.navy.mil/atos

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